Particle Ratios at Mid-rapidity in $\sqrt{s_{NN}}$ = 130 GeV Au+Au collisions

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for the STAR Collaboration

ThermalFest - July 20, 2001

What are we looking for?

- What is the initial environment like for particle production?
  - Net baryon density

Baryon / antibaryon ratios

- What happens during the initial particle production?
  - Strangeness production
  - Quark coalescence?

Strange hadron / h- ratios

Quark-counting ratios

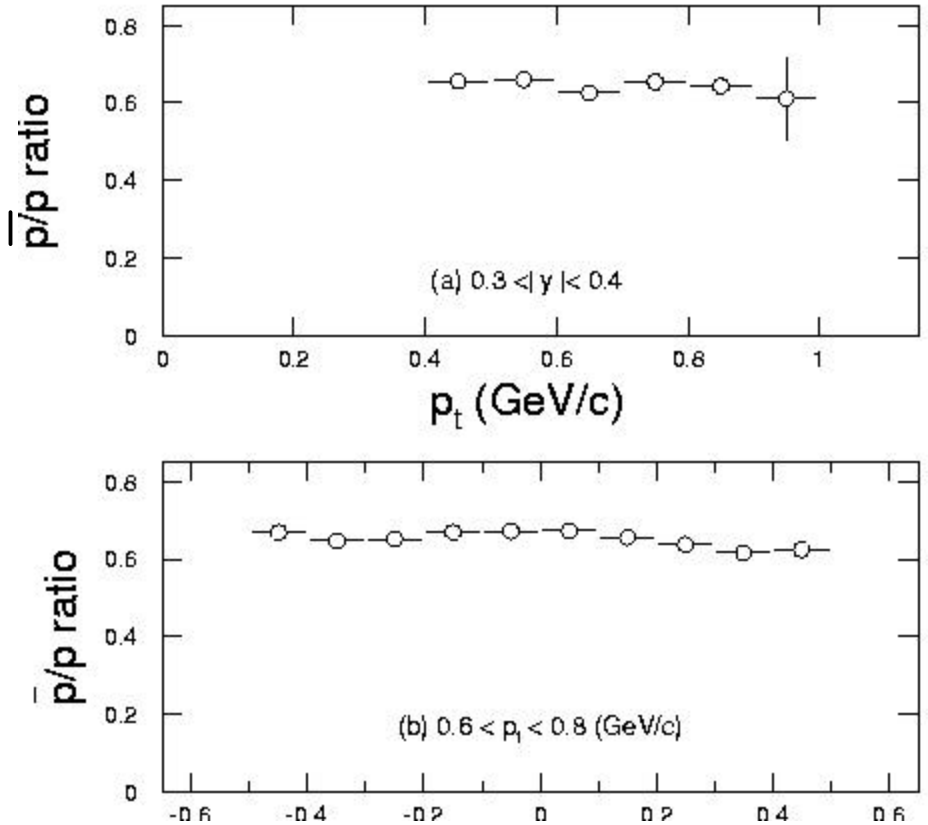
- Are re-interactions significant?
  - Rescattering of hadrons
  - Equilibration of strangeness

Hadron ratios vs. p_t

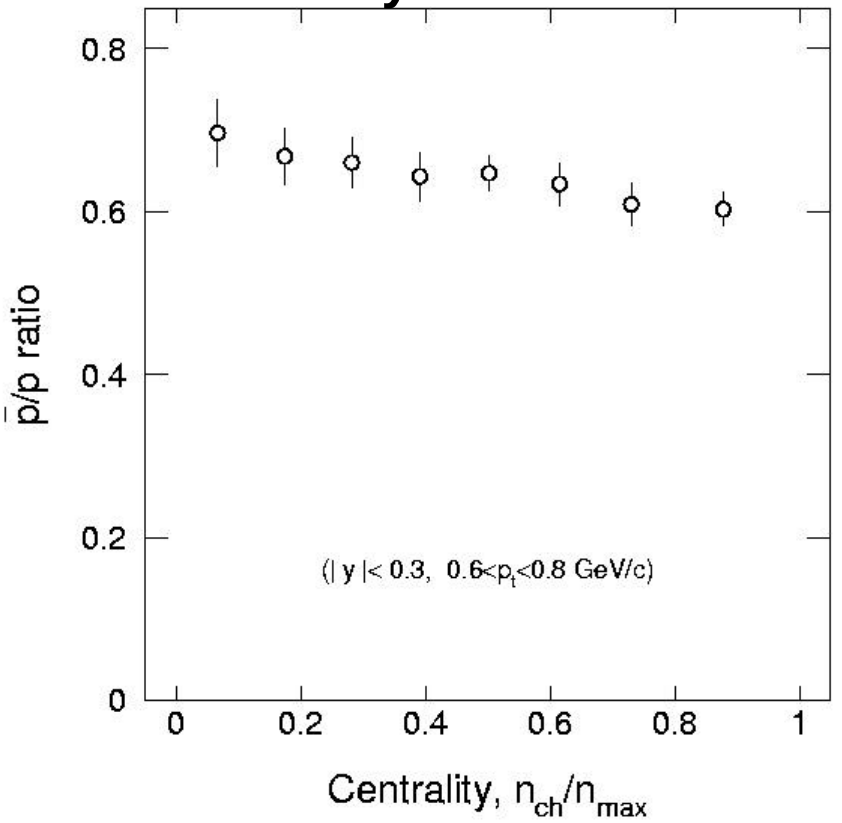
Strange baryon ratios

$\bar{p}/p$ Ratios

Ratio is flat as function of p_t and y



Slight fall with centrality



No feeddown corrections included, but expected to be small

Ratio = 0.65 ±0.03(stat) ±0.03(sys)

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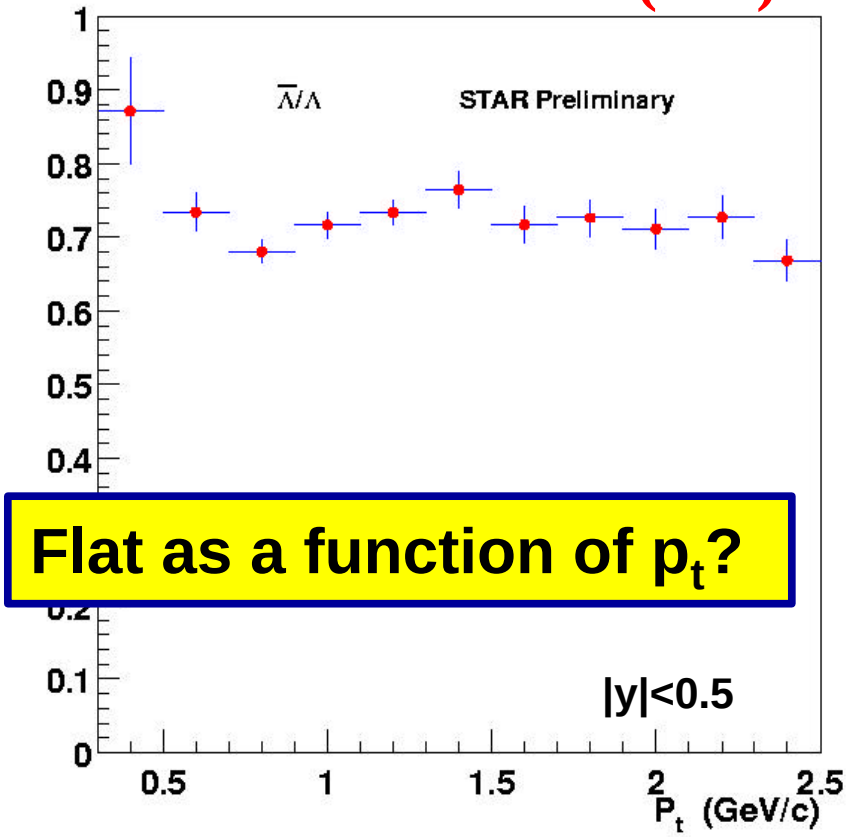
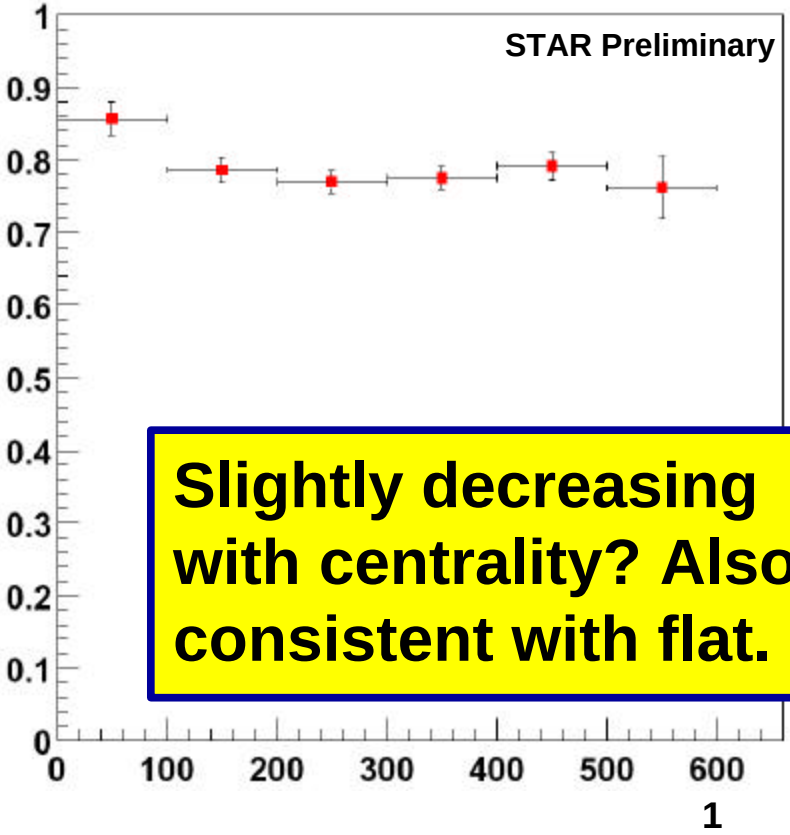
$\bar{\Lambda}/\Lambda$ Ratios

$\bar{\Lambda}/\Lambda = 0.73 \pm 0.03$ (stat)



Flat as a function of p_t?

Central events



Slightly decreasing with centrality? Also consistent with flat.

Averaged over experimental acceptance in p_t

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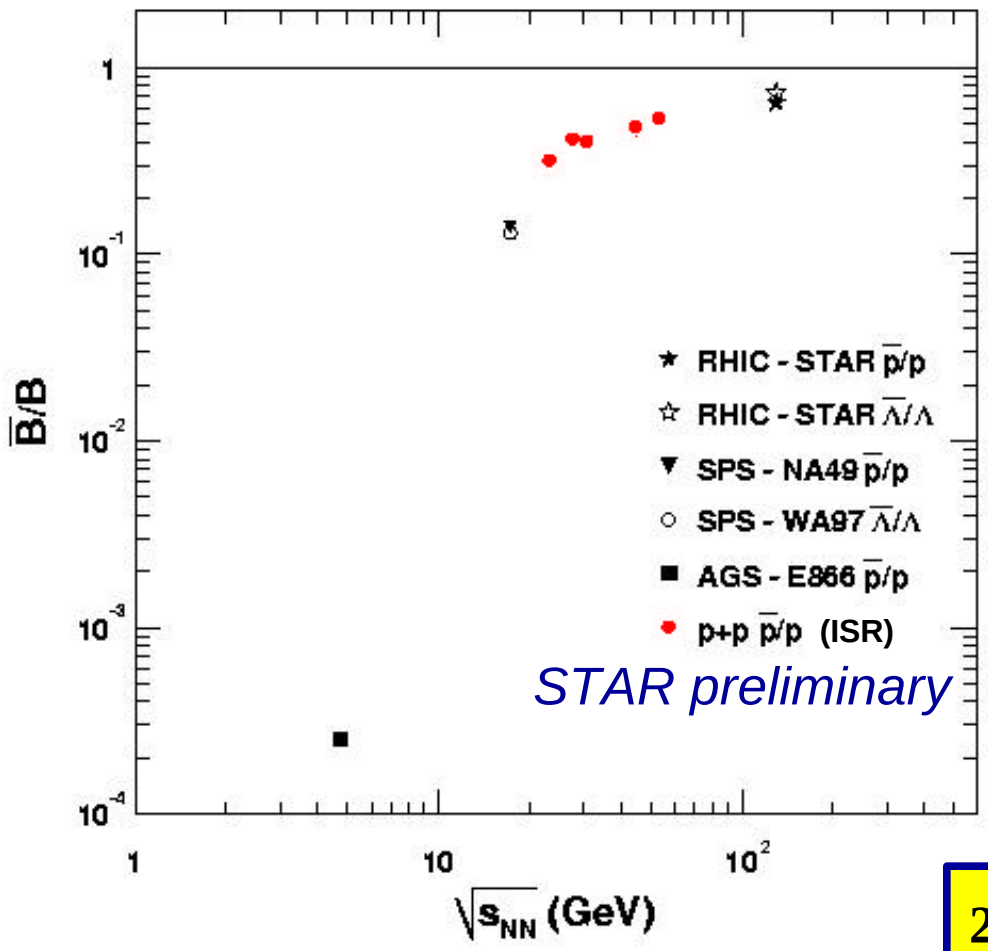
Energy Evolution of $\bar{B}/B$ Ratio



Production of baryons through pair processes increases dramatically with Ös – still not baryon free

$$\frac{Y_{pbar}}{Y_p} = \frac{Y_{pair}}{Y_{pair} + Y_{Tr}} \approx 0.65$$

$$\frac{Y_{pair}}{Y_{Tr}} \approx 2$$

Pair-process production is larger than baryon transport

2/3 of protons from pair processes , yet pt dist. the same as antiprotons

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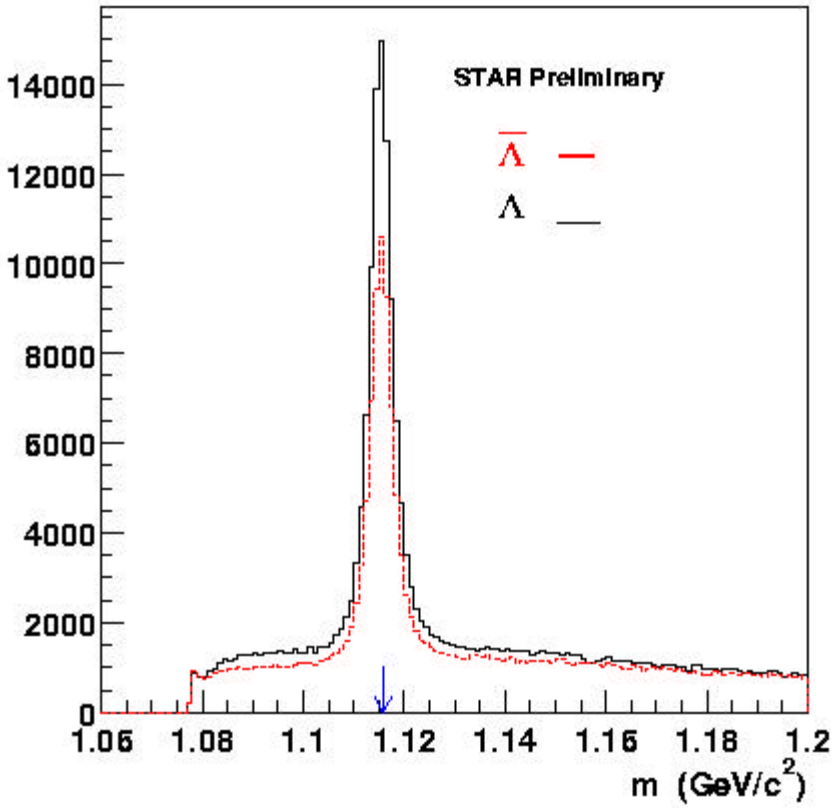
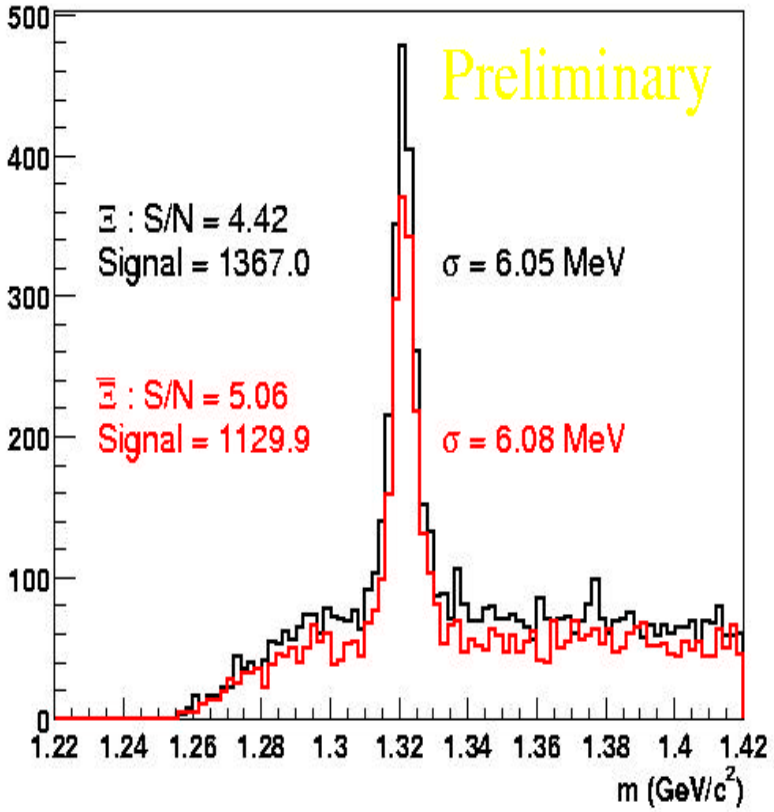
The Λ and Ξ Baryons

High quality data for strange and doubly strange baryons!





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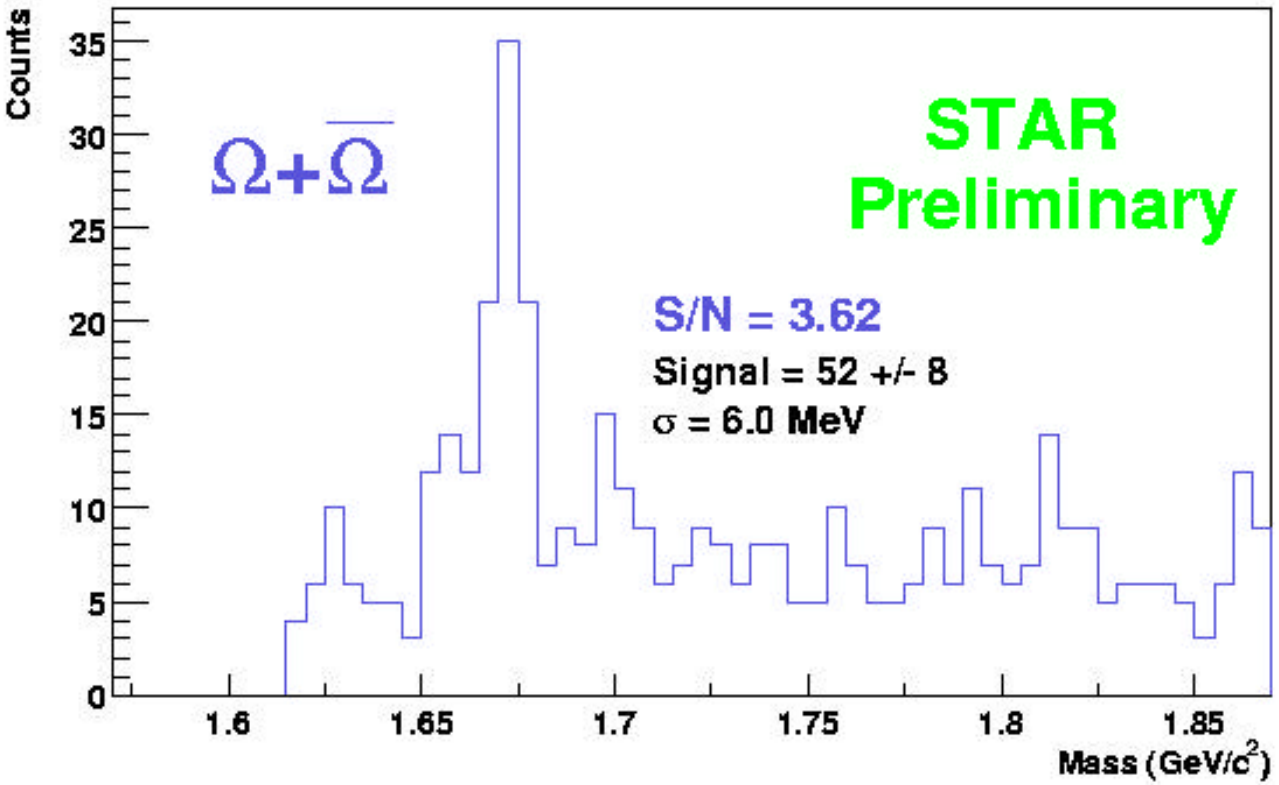
The Ω Baryon

Peaks are evident, but statistics are low.

Ratio on the order of 1 with large stat. errors presently.



15% Most Central

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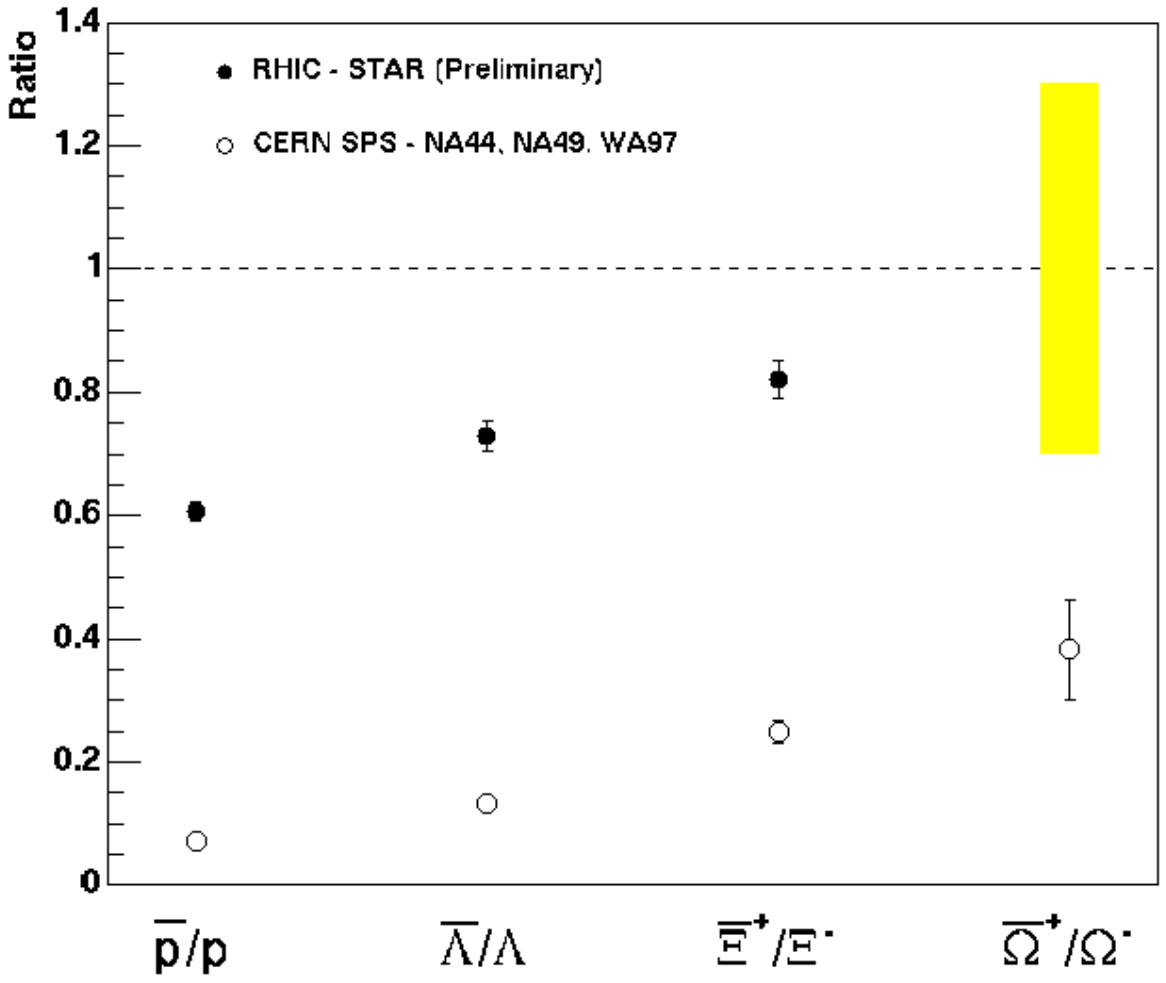
STAR $\bar{B}/B$ Ratios

Ratio approaching 1.0 as strangeness content increases

Ratios calculated for central events at mid-rapidity, averaged over experimental acceptance in p_t



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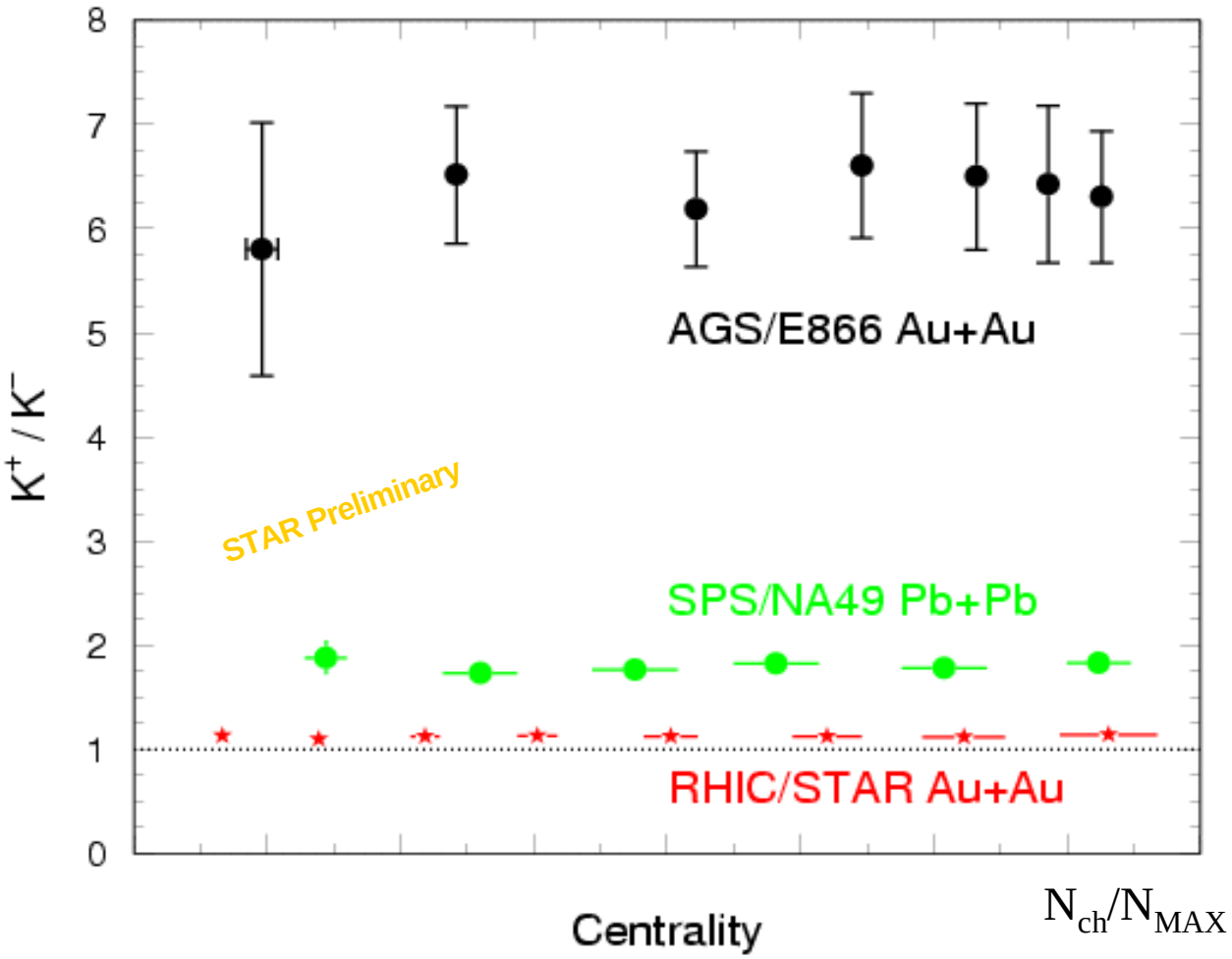
K^+/K^- versus Centrality

K^+/K^- constant over measured centrality



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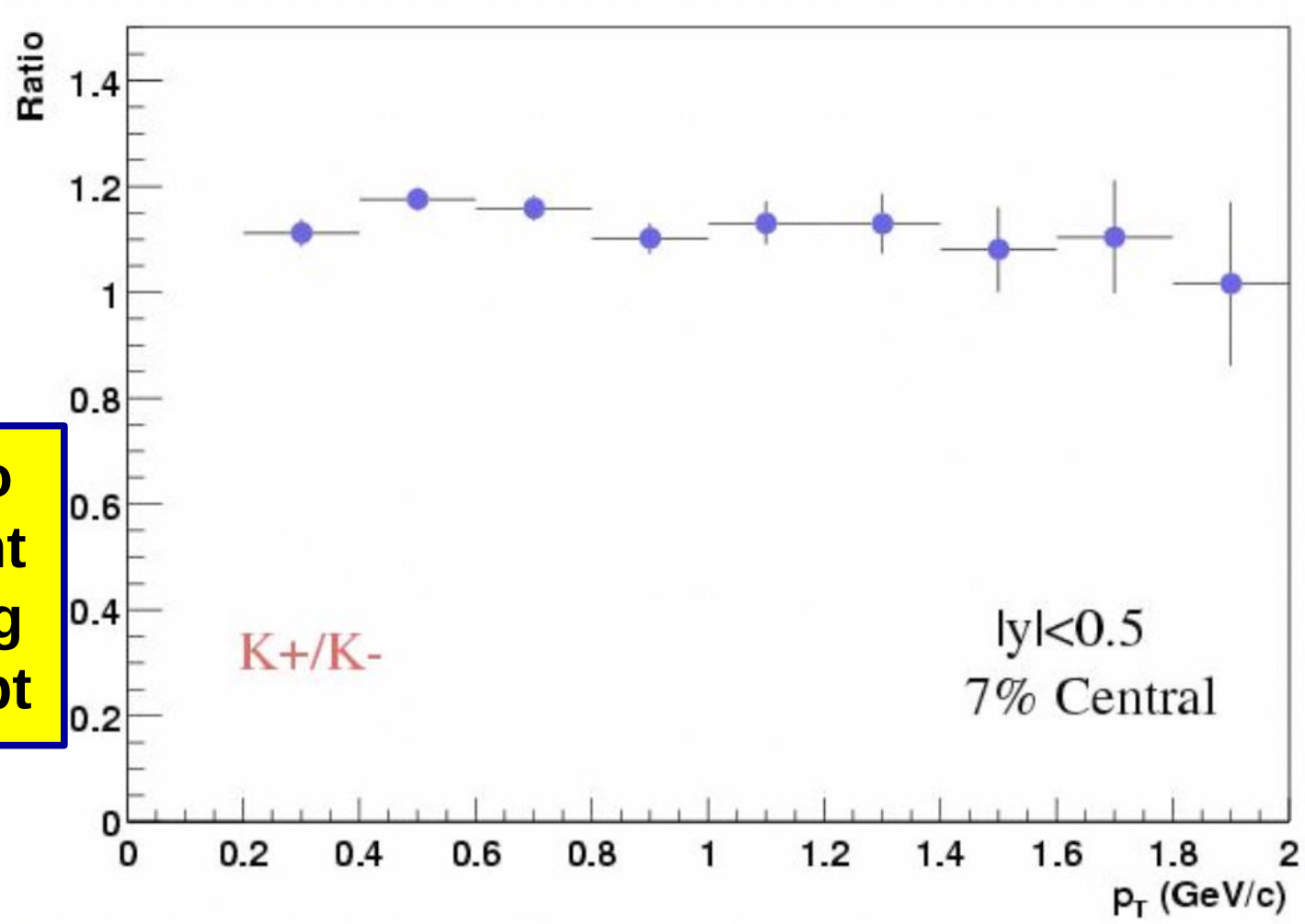
K^+/K^- versus Pt

K^+/K^- ratio consistent with being flat over pt



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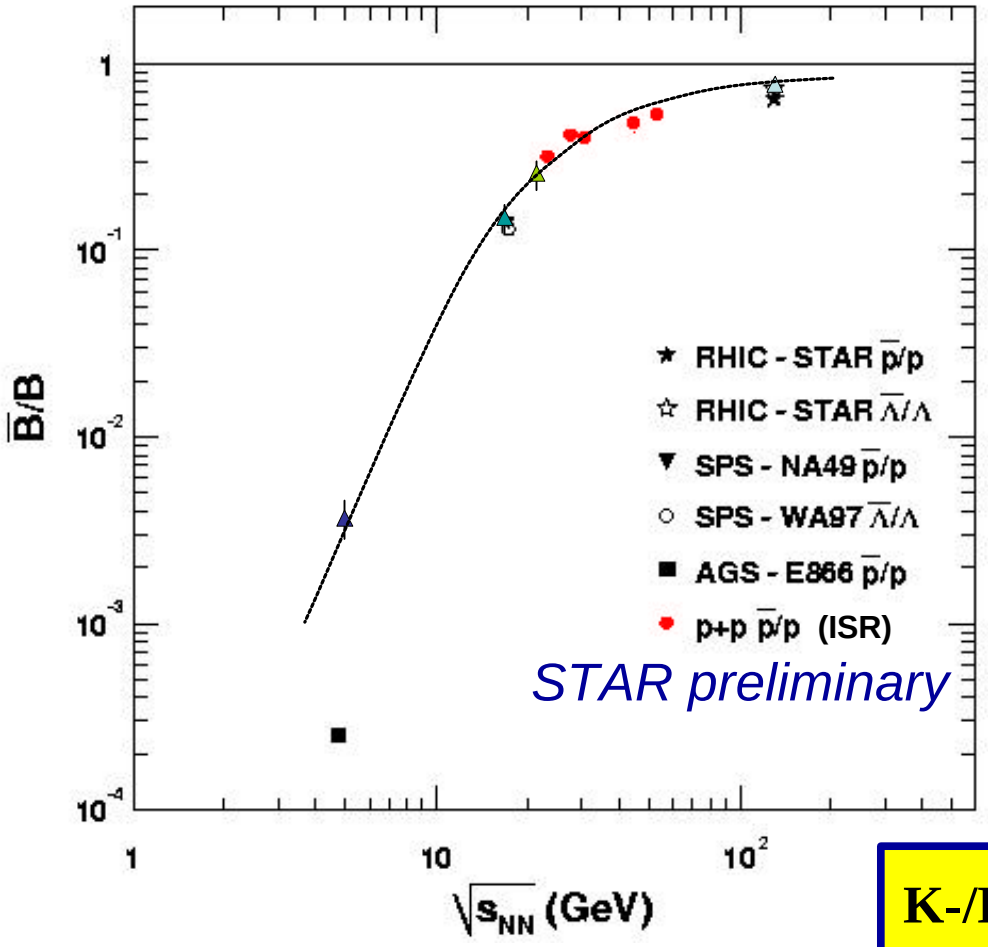
Energy Evolution Revisited



RHIC/STAR (Au+Au)
SPS/NA44 (S+S)
SPS/NA49 (Pb+Pb)
AGS/E866 (Au+Au)

$$\frac{Y_{K^-}}{Y_{K^+}} \approx \frac{Y_{ubar}}{Y_u} = \frac{Y_{pair}}{Y_{pair} + Y_{Tr}}$$

$$\frac{Y_{pair}}{Y_{Tr}} = \frac{Y_{K^-}/Y_{K^+}}{1 - Y_{K^-}/Y_{K^+}}$$

$$\frac{Y_{\overline{B}}}{Y_B} \approx \left(\frac{Y_{ubar}}{Y_u}\right)^3 \approx \left(\frac{Y_{K^-}}{Y_{K^+}}\right)^3$$

K-/K+ ratios exhibit similar behavior to $\overline{p}/p$ at well-above threshold energies

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Quark-Counting Ratios

$$\frac{\bar{\Lambda}}{\Lambda}\left[\frac{\bar{u}\bar{d}\bar{s}}{uds}\right] = \left(\frac{u}{\bar{u}}\right) * \left(\frac{\bar{s}}{s}\right) * \frac{\bar{p}}{p}\left[\frac{\bar{u}\bar{u}\bar{d}}{uud}\right] = D * \frac{\bar{p}}{p}$$

Predict

$$\frac{\bar{\Xi}}{\Xi}\left[\frac{\bar{u}\bar{s}\bar{s}}{uss}\right] = \left(\frac{u}{\bar{u}}\right) * \left(\frac{\bar{s}}{s}\right) * \frac{\bar{\Lambda}}{\Lambda}\left[\frac{\bar{u}\bar{d}\bar{s}}{uds}\right] = D * \frac{\bar{\Lambda}}{\Lambda}$$

Predict

$$D = \left(\frac{u}{\bar{u}}\right) * \left(\frac{\bar{s}}{s}\right) = \frac{K^+}{K^-}\left[\frac{u\bar{s}}{\bar{u}s}\right]$$

Measure

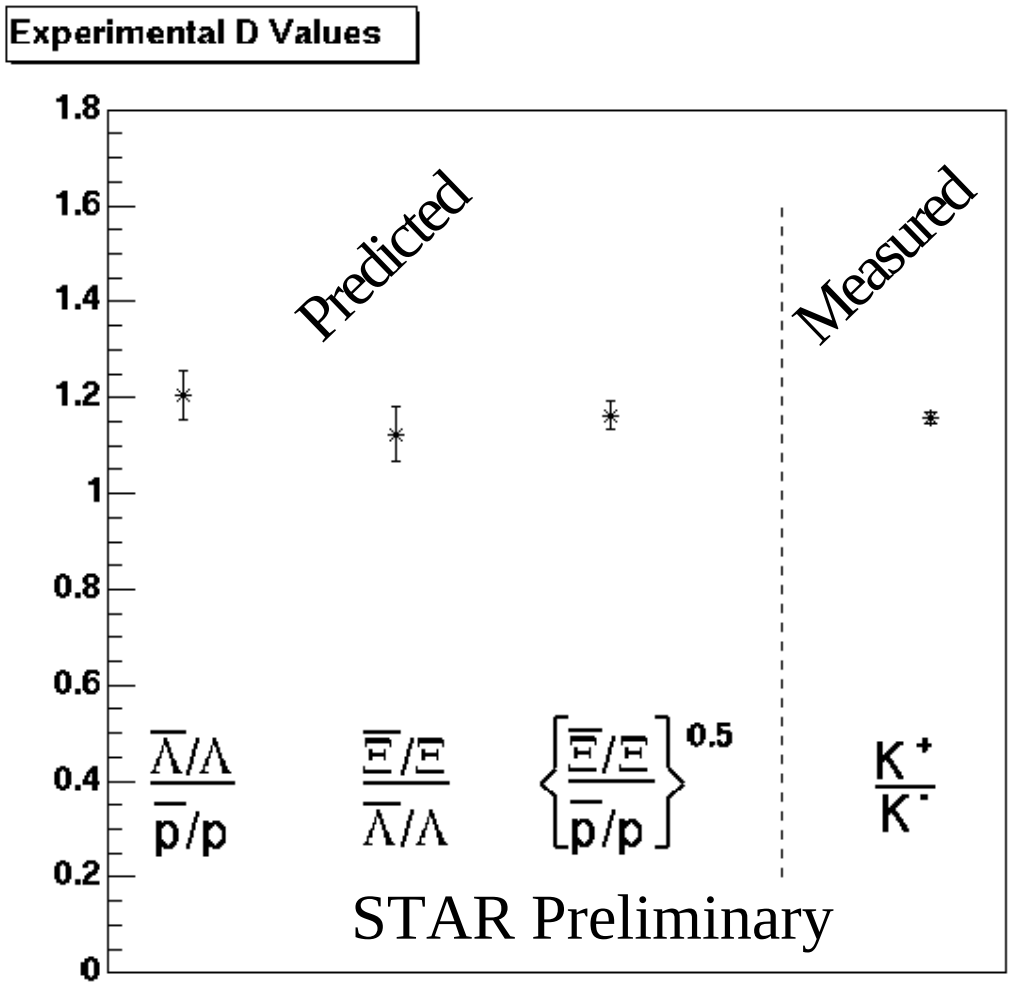
Phys. Lett. **B**347 (1995) p6

Quark-Counting Ratios

Quark-counting ratios are consistent with each other

Will change slightly with feeddown corrections (not included here)

Statistical errors only



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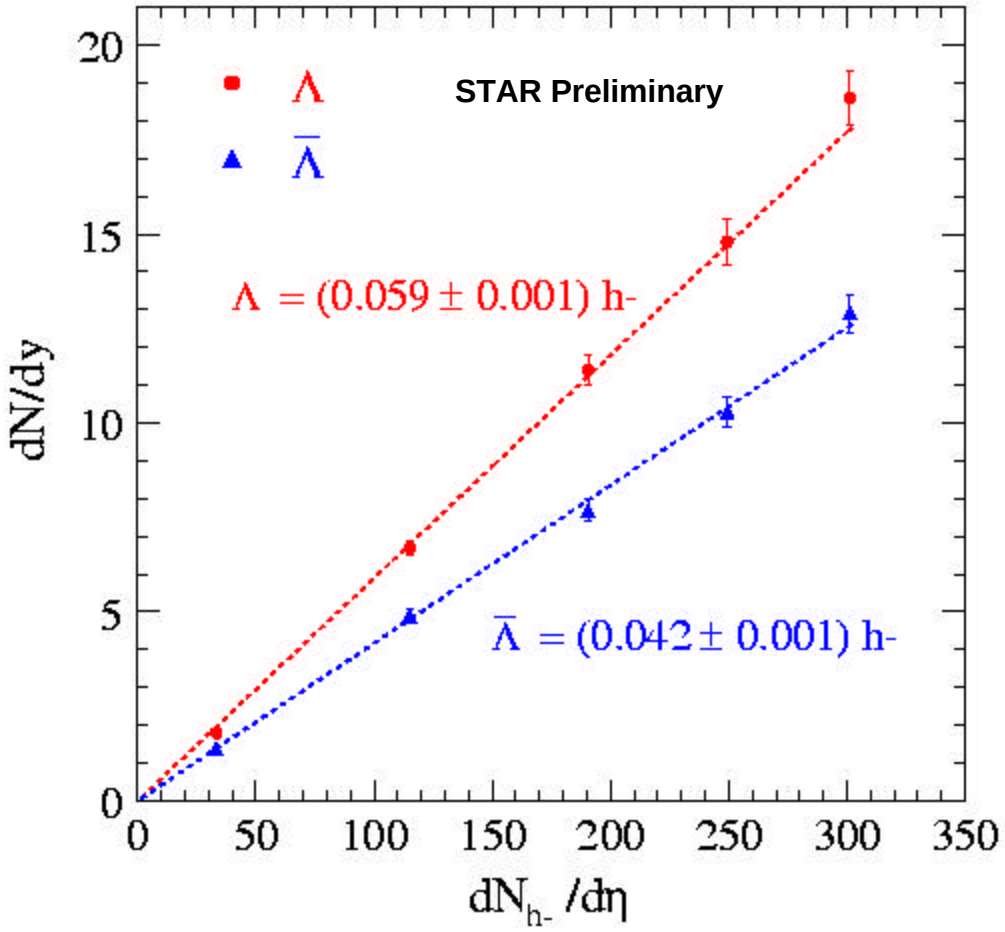
Λ, $\bar{\Lambda}$ fractions of h^-

Note: spectra are not feed-down corrected

L yields are from fits to Boltzmann; h^- yields are power law fits



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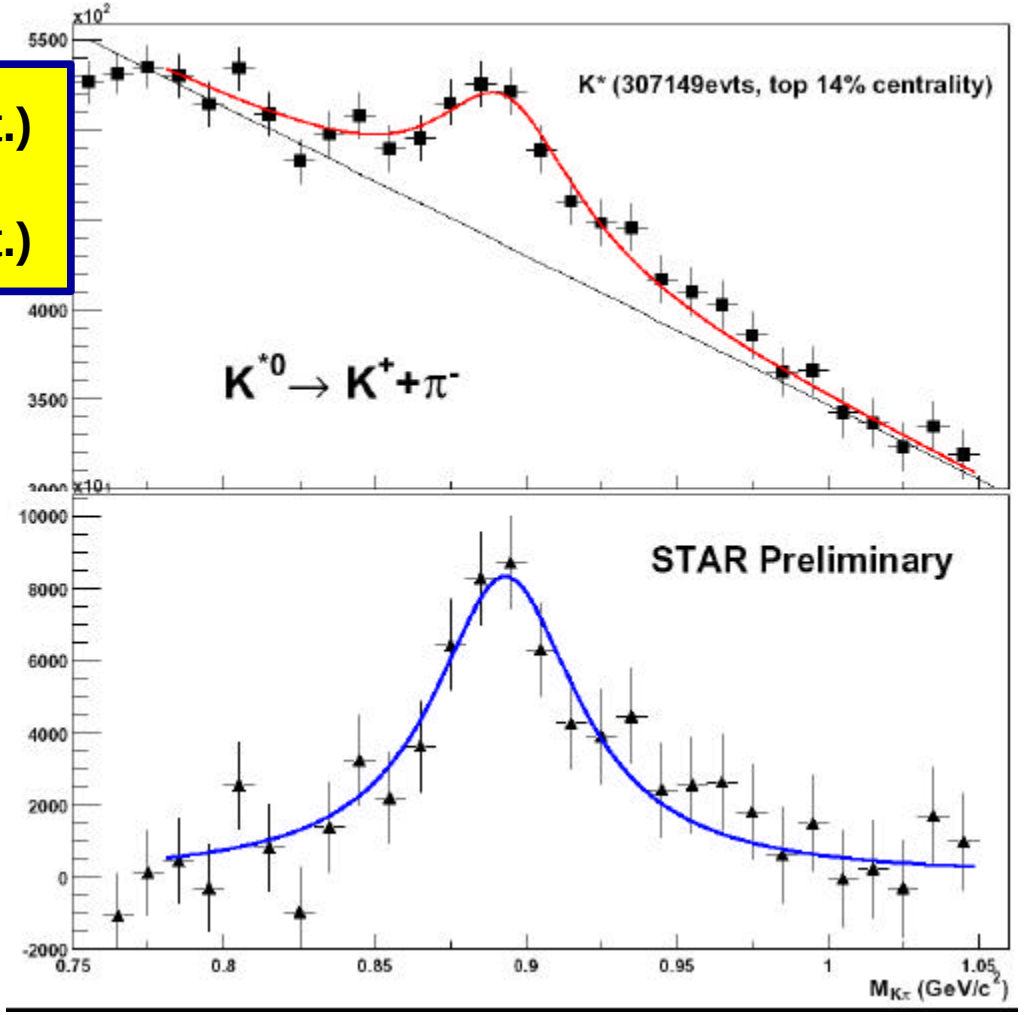
K^{0*}, $\overline{K^{0*}}$ Ratios

$K^*/h^- = 0.060 \pm 0.006$ (stat.)

$\overline{K}^*/h^- = 0.058 \pm 0.006$ (stat.)

20% systematic error from assuming 300 MeV inverse slope in efficiency calculations.



K^*: $|y| < 0.5$,
$0.2 < p_t < 2.0$ GeV/c
h^- : $|\eta| < 0.5$,
$p_t > 0.1$ GeV/c

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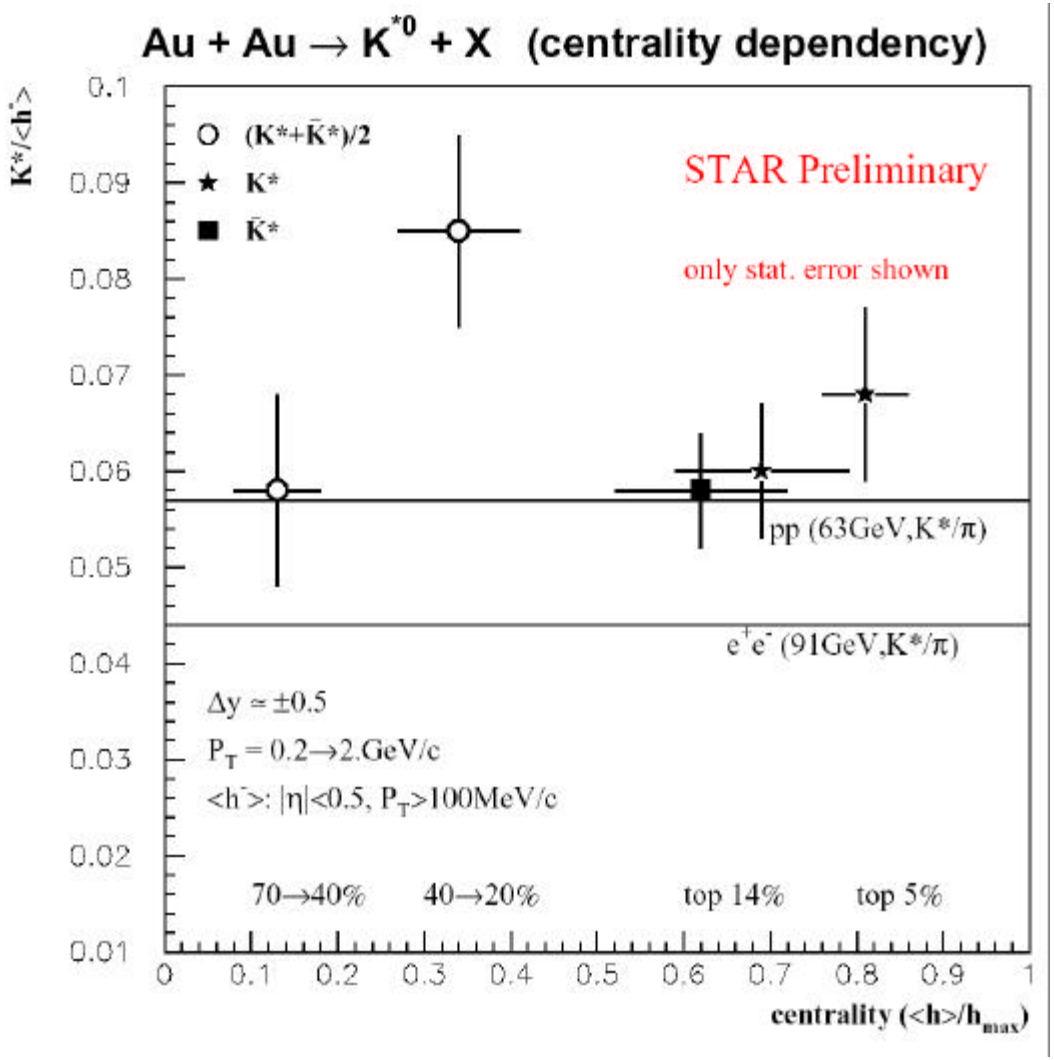
K^{0*}, $\overline{K^{0*}}$ Ratios

K*/h⁻ compatible with K*/p⁻ from elementary particle collisions



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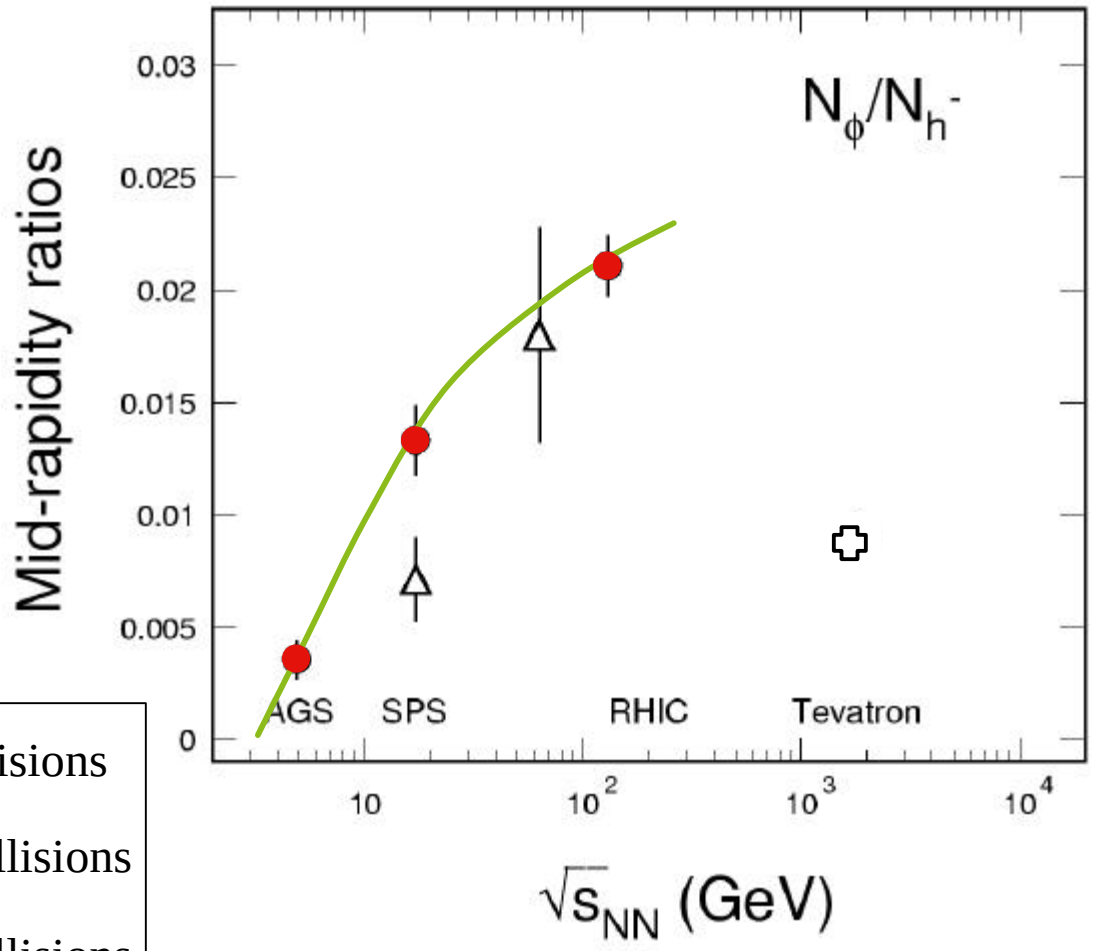
Φ Ratios

Relative production of ϕ increasing with collision energy in heavy ion collisions.



- HI collisions
- △ p+p collisions
- p+$\bar{p}$ collisions

What were we looking for?

- What is the initial environment like for particle production?
  - Net baryon density

Still a significant amount of baryon number around

- What happens during the initial particle production?
  - Strangeness production

Increasing fraction of particle production with energy, but not centrality?

  - Quark coalescence?

Reasonable predictor

- Are re-interactions significant?
  - Rescattering of hadrons

Little p_t dependence, significant rescattering?